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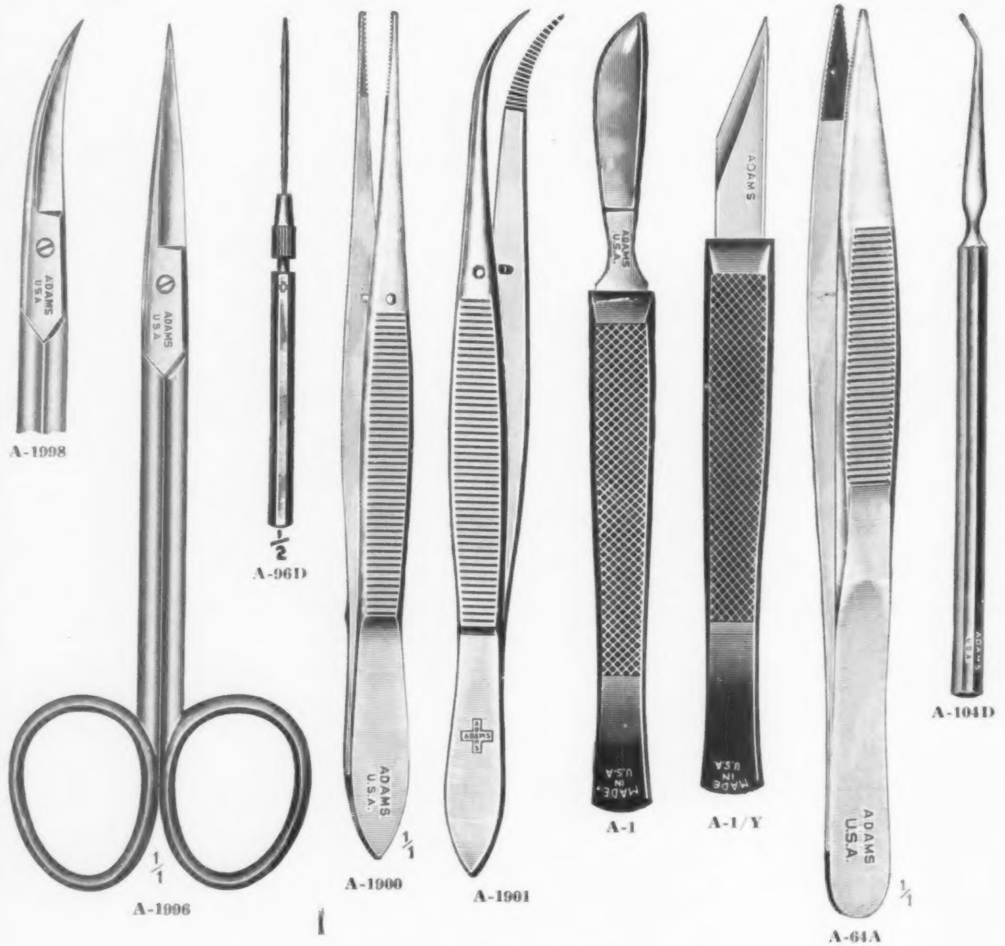

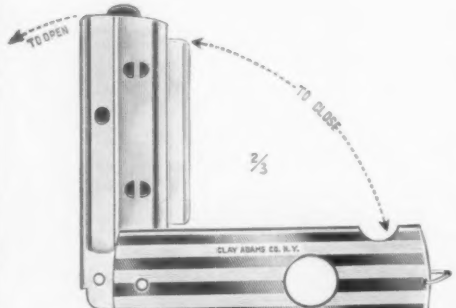

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The American Biology Teacher

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The Importance of Biology Teaching for Secondary School Pupils

PAUL SEARS
Oberlin College

Biology is the link—still too largely a missing link—between the physical and social sciences. Through it, and it alone, can the student come to understand the natural communities of plants and animals which, during the centuries, have shaped his own region for its present human utility. He can moreover be made aware of the impact of man upon these natural communities, and the resultant change. He will come to realize how the changes produced by man, in destroying forests, prairies, and wild life, have in turn reacted upon his own economic life. And he is prepared to understand that man faces the task of building a new type of organic community if he is to survive. In this community, while man remains the dominant organism, he must be able to make a place for many kinds of plants and animals to function in their proper relationships. He will understand the natural community, not merely as an outworn curiosity, but as in many respects the model for his own communities in the future.

I find it difficult to think of biology, or any science, in terms of any one level of instruction. The truth is, that in a world so profoundly altered by science as ours, there should be no break in the steady process of teaching the operations of the scientific mind and the use of symbols in connection with the objects to which they refer. If this were done from the beginning, our people would soon become scientifically literate and articulate, and language instruction itself would rest on a far firmer basis than it does today. We would have a better sense of the great forces which are at the disposal of our culture if we control them, and which may wreck that culture if we do not. And I am certain we should in our social and political life, suffer, far less from "word trouble" than is now the case.

Yet as matters stand, a heavy burden

will continue to rest upon the secondary level. Here, then, we must strive to develop the values I have just referred to, most of all by basing our instruction upon direct and convincing experience with the things we are talking about. We must make our start with the familiar and commonplace, and use it for all it is worth. The immediate surroundings of the pupil, even in a large city, can be made to supply this material. The love of the secondary school pupil for glib catechismal instruction must not blind us to the fact that a person may know a thousand biological terms and still be biologically ignorant.

Having thus reaffirmed my faith in the importance of biology as a factor in the education of our young people, I find it necessary to make some reservations. There seems to me just one decent reason for teaching any subject at any level of education, and that is the good it will do the pupil and the society of which he is a member. Judged by that standard, much that is labelled biology fails to qualify. I speak from a number of years of close observation of young people who are passing through the mill. If you wish confirmation from the behavior of citizens who have been through it, I refer you to the general standard of community attitudes upon such matters as sewage disposal, public health measures, and the utilization of soil, forests, and wild life.

Furthermore, the progress made in personal hygiene among the American people is due at least as much to commercial enterprise as to a growing knowledge of biological principles. And the newer attitude towards sex is in large part of an outgrowth of social pressures which had become intolerable, however much biological knowledge may have played a part in this and other changes which are slowly going on.

By and large, being an overworked profession, we teach what we have been taught. If we have picked up a casual and shoddy "overview" of biology as an incident in our training, that represents what we have to offer. If we were trained in a great university whose biology departments were preoccupied with counting chromosomes, or with tracing morphological homologies in plants, that again is what we are likely to unload. Only the remarkable improvement in text-books and visual aids keeps us from doing worse than we do. It should be understood that I speak of the rank and file, for it is my opinion that capable individuals in secondary schools are here and there setting the pace for institutions of higher levels.

As I examine the work these men are doing, I find that they realize themselves to be teaching living and growing human beings to understand the behavior of *living* organisms, and the relations which exist among those organisms. They have escaped from what we might call, following Mr. Wells, the "deadly grammar of the dead cat." They are mindful of the stuff which a pupil ought to be expected to keep and use as long as he lives—not wholly in a utilitarian sense, by any means. They see a certain inappropriateness in solemnly learning the details about mysterious and remote "types" when a student does not know the weeds and insects in his own door-yard. To them phyletic sequences and alternation of generations—excellent matters in their way—are of less immediate import than the great facts of organic development and the community relationships of living plants and animals.

I should say, also, that these teachers of whom I speak are less concerned with their freedom to teach than with the quality of their own workmanship as teachers. Good teaching, done with a

sense of the cultural pattern of the community of which both teacher and pupil are a part, inevitably carries its own conviction. The teachers to whom I refer realize that teaching is an art, and that like all arts, it must conform to the limitations of its material and media. They know that they must begin with the material at hand—the language and experience of the community in which they live. Only in that way can they move ahead.

May I be so rash as to drag forth a sacred cow for examination? I speak of the question of Evolution. Ever since I was able to take part in rational conversation in my own home, evolution has been accepted by me as a matter of course. This is not true in all homes, including many of those from which our pupils come. Nor is this all. So great was the impact of the doctrine of evolution upon scientific thought, that I venture to say it has injured our sense of proportion.

In much of our teaching we have been so concerned to put "evolution" across that we neglect both the basis upon which it rests, and the implications which flow from it. We forget that it is merely a special case of the great principle of change and transformation which should run through all of our science teaching, through the social sciences, and the humanities. And we very seriously neglect the fact that, during the lifetime of any one individual, the process of evolution, in the classical sense, is proceeding most deliberately. His own problems arise for the most part from the interactions and behavior of organisms that, for practical purposes, are the product of a past evolution. Though he trace the sequence of the horse and the seed-plant with perfection, if he knows not how to look at a horse, or watch the behavior of a living plant, he has little understanding of the laws which operate in the realm of the living.

As I view the matter, it is an extremely serious thing when a group comes before the American people and announces that it has something important for their children. There is no magic in the word "biology" which will justify whatever may be taught under that rubric. What good may be expected from what kind of biology? And have we as secondary school teachers ourselves been taught the sort of thing that is needed?

At the risk of seeming ungracious, I would suggest that our first task is a thorough self-examination.

DUES NOW PAYABLE

Pledged members of The National Association of Biology Teachers may pay their dues to a local, state, or regional representative. Any member may, if it is more convenient, remit dues to Mr. P. K. Houdek, Township High School, Robinson, Illinois.

It is extremely important at this early stage in the life of the association that those who have pledged their membership support the activities of the association by paying their dues immediately.

In some cases dues and memberships have passed through three or four hands before reaching the secretary-treasurer. Any member who does not receive a membership card within a reasonable time after transmitting dues should communicate with the secretary-treasurer, Mr. P. K. Houdek, Township High School, Robinson, Illinois, giving the date dues were paid and to whom they were paid.

The Migrations of Fishes

GEORGE W. JEFFERS
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It is to be regretted that the subject of migrations has been so largely restricted to birds, with the result that the migrations of other animals are likely to be overlooked. In spite of extended study no one cause or set of causes has been found to account completely for the migrations of birds although many of the factors involved are well known. In the case of the other groups the underlying causes do not appear to be so baffling, and it might be profitable for students of the subject to divert more attention to migratory species other than birds.

Two general types of animal migrations are recognized. First, are the mass movements from one region to another of irregular occurrence known to occur among insects such as butterflies, locusts and dragon flies. These are spoken of as *sporadic migrations* and have been explained as irregular dispersal movements. To this same class also belong migrations of squirrels and certain bats, while the classic instance is that of the lemming, a small mammal of northern Europe.

In the second place, are *rhythmical migrations* which are regular periodic movements from one zone to another so well illustrated in birds. Some species of seals spend as much as three-fourths of the year in travel. Rhythmical migrations are the expression of an innate urge and, in a sense, they alone are true migrations.

In the study of fishes the term "migration" is frequently employed to express various sorts of mass movements that are not rhythmical in nature. For example, the eggs and larvae of many species are subjected to an involuntary drift due to winds and ocean currents. This is known as a *denatant migration*. The term *feeding migration* is used for those voluntary movements of adult and partly-grown fish in search of food. The tendency of pelagic life, including young fishes, to come to the surface at night and to descend during the daytime when the sun is brilliant is spoken of as *vertical migrations*. Then there are the *seasonal migrations* of many fishes, particularly immature fishes. Frequently large schools of fish roam about from place to place more or less haphazardly. Such movements are more correctly termed 'meanderings' and are not always as haphazard as they appear on the surface, but are definite responses to environmental factors the most important of which appears to be temperature. In this paper we shall be content to describe briefly the spawning migrations of certain fishes since these are innate and have been of great economic importance because upon them are based most of the great sea fisheries of the world.

The salmon is perhaps the most familiar example of a migratory fish. This noble fish spends its adult life in the sea but always returns to fresh water to spawn. This transition from one medium to another, from salt water to fresh, entails an adjustment of no small moment on the part of the animal. Some Pacific salmon travel upstream to a distance of more than a thousand miles and it may take a year from the time the fish comes in from the sea until its reproductive function has been accomplished. It ascends rivers often against strong currents and leaps numerous waterfalls; the male

fights other males and wards off enemies and prepares the crude nest into which the female lays her eggs.

It seems almost incredible, therefore, that the salmon does not feed in fresh water. To be sure it sometimes rises to the fly if it is tempted enough, particularly shortly after it first enters the river. It snaps at the fisherman's fly in much the same manner that it would snap at any tormentor. Its reaction in this case is not a feeding response. In fact, the digestive organs of the fish undergo a certain amount of atrophy during its stay in fresh water. The food necessary for the tortuous journey upstream as well as that required for the rapidly-developing eggs comes from materials already stored up in the body. When the salmon first comes from the ocean it is sleek and well-fed. Very soon thereafter it loses its silvery sheen and takes on a dull brown or reddish hue; the very contours of the body become altered and by spawning time the animal presents a dilapidated appearance, much more pronounced in the male. After spawning the fish drifts helplessly tail-first down stream, completely exhausted. Little wonder that on the Pacific Coast where the rivers are very long they all die without regaining the sea. The mortality is one hundred percent. On the Atlantic Coast and in some countries such as Scotland, the rivers are shorter and some of the fish get back to salt water where they rapidly recover and may return to spawn another year.

Meanwhile the eggs which were deposited in the autumn develop slowly in the low temperatures of winter and so do not hatch until the following spring, by which time the adults have all succumbed. After two or three years in fresh water these young salmon move down stream and very little is known of their movements after they disappear from the coasts. It is now generally believed that they do not wander far from the mouth of the particular river in which they were spawned. However, they grow rapidly on the abundant diet afforded by the sea and, as maturity approaches, usually at the end of two or three years, they respond to the great natural urge which in the case of Pacific salmon involves the supreme sacrifice. They come back to the same river and ascend it to the same identical stream in which their larval life was passed. There they spawn and die. This parent-stream theory is pretty generally accepted although it has been questioned on the grounds that those fish that go out beyond the influence of the parent river sometimes get lost and may go up another river when they return to spawn.

The term "anadromous" is applied to fishes such as the salmon that go from salt water to fresh in order to spawn. Formerly the term was restricted to those fishes that actually entered fresh water, but it is now more correctly used for any fish that moves shoreward, from deeper to shallower water, to spawn.

All salmonoid fishes are anadromous at least to some extent. The salmon itself is merely an extreme example. In reality it is almost a fresh water fish. Sometimes young salmon do not go to the sea until their third, fourth or even their sixth year and an occasional male has been known to become sexually mature without going to sea at all. Some salmon become landlocked, that is, they never leave fresh water.

Other salmonoids such as the whitefishes and the trouts are confined to fresh water almost entirely, only occasionally running down to the ocean. Even these fresh water salmonoids are anadromous, as witness the fact that trout migrate from ponds and lakes into smaller feeder streams for spawning. The smelt is a

close relative of the salmon. It also leaves the sea to spawn in fresh water although it never goes very far up stream nor remains very long. Smelt, too, become landlocked, becoming fresh water smelt. Here again the anadromous habit exhibits itself because these landlocked smelt move up into shallow streams to spawn.

Another small salmonoid, closely related to the smelt, is the caplin (*Mallotus villosus*). This boreo-arctic species is exclusively marine. It winters in the deeper waters adjacent to the coasts and in springtime moves shorewards in enormous numbers to deposit its eggs right up on the sandy beaches. Naturally the mortality is extremely high but it is doubtful if all the adults perish. In the warm moist sand which acts as an incubator the eggs are ready to hatch in two weeks. Since they are deposited on the beaches only at the time of the high tide, it is a remarkable adaptation that the larvae are ready to emerge at the time of the next high tide—two weeks hence—and thus regain their watery medium. Otherwise they would all likely perish in the sand. A quite similar life history has been reported for the grunion (*Leuresthes tenuis*), a close relative of caplin found on the coats of California.

Artificial incubation of the eggs of caplin likewise reveals the anadromous nature of the species. The developing eggs tolerate a wide range of salinity, and hatching is more or less successful in water ranging from pure sea water all the way down to water that is almost fresh, for example, one part sea water to nine parts of fresh water, provided the temperature remains within the optimum. There is actually a larger percentage of normal hatching and hardier larvae are produced (as judged by the length of larval life without feeding) in one-quarter sea water than in pure sea water. Here then is a strictly marine species whose eggs actually develop better in a medium that is radically different from that tolerated by the adult. This fact has some phylogenic significance since it points to a fresh water origin for the salmonoids rather than favoring the view of some that they are just establishing themselves in fresh water.

As with the salmonoids, so with the clupeids (herring, shad, etc.) and the scombroid fishes (mackerel, tunny, etc.). They all exhibit the same general type of spawning migration, from deeper to shallower water. Some, like the herring and mackerel, merely move into shallow water, other like the shad ascend streams; still others are permanent inhabitants of inland seas.

Among the gadoids (cod, haddock, etc.) the anadromous tendency is still traceable. The cod spawns in later winter and early spring, moving to inshore banks for the purpose. Many of the stationary fishes of shallow water migrate very little at spawning time. Some of them undertake short anadromous journeys while a few seem to move in the reverse direction.

A migration for the purpose of spawning in the reverse direction, from shallow water to deep, is termed 'catadromous'. Such migrations are rare. To be sure a few fishes, the angler and the European flounder for example, seem to move into slightly deeper water but the distance covered would scarcely justify the word 'migration'. The catadromous habit of such fishes is feeble at best and pales into insignificance when compared with the almost unbelievable breeding behavior of the common eel.

The ancient Greeks long puzzled over the mystery of the eel and naïvely explained it by saying that eels were the children of Father Neptune. No sexually mature eel has ever been found among the millions of individuals that

are captured annually. That mature eels leave the rivers and lakes and journey down to the ocean in autumn has been known for centuries, but only within the present generation has the mystery of their breeding place been solved, largely through the very painstaking investigations and brilliant deductions of Doctor Johannes Schmidt of Denmark.

The life history of the eel is now fairly common knowledge and it can be repeated here only in its barest outlines: Both the European eel (*Anguilla anguilla*) and the American eel (*A. rostrata*) spawn in the same general region—an area of the Atlantic Ocean between Bermuda and the West Indies where the water reaches a depth of a mile. The American species spawns slightly to the west of the European species, the two spawning areas overlapping somewhat. The eggs are laid at depths of about 650 feet and the newly-hatched larvae continue to rise to the surface as they grow. At this stage and until they reach their respective shores they are so completely unlike the adults that for long they were believed to be a separate species. This larval stage, known as *Leptocephalus*, is laterally compressed, as thin as a leaf and so transparent that the vertebrae of the backbone can be counted without difficulty. The only difference between the American and the European species is that the latter has a few more vertebrae.

The two schools of larvae start out together and move northward and, guided by some instinct which we completely fail to understand, they separate, one going east to Europe and the other west to America. No specimen of the former has ever been taken in America or of the latter in Europe. The European eel takes about three years before completing its metamorphosis while the American species takes much less time, evidently about a year. The principal changes that occur include a reduction in the depth and length and an increase in thickness, the loss of larval teeth and other head changes, and the digestive tract becomes functional perhaps for the first time. The transformation is completed by the time they reach the coast.

The young "elvers" appear along our shores in spring at which time they average around three inches in length. It is now generally believed that only the females ascend the rivers and that any eel caught in fresh water is a female. After about five years in fresh water they begin to make their way down to the sea as "Silver Eels" because of a change of color. They have already ceased to feed and in the estuaries they are joined by the waiting males. Together they disappear from sight around the month of November and by January they have reached the common spawning grounds. Since no adult eels have ever been observed going up a river it is assumed that they all die after spawning.

Although the main facts of the life history of the eel were pieced together by Doctor Schmidt, it remained for a young American woman to be the first ever to see the eggs and thus to furnish the final clue to the solution of a mystery that has puzzled scientists since the time of Aristotle. During the Arcturus Expedition Mrs. Marie Poland Fish collected three strange fish eggs from the carapace of a crab that had come up in the dredge. These she carefully kept in the laboratory on board ship until they hatched out into tiny leptocephali.

From these illustrations it will be seen that migrations in fishes differ from bird migrations in some important respects. With fishes the migrations are not seasonal in the sense that this is true in

birds, neither do the young take part in them. Fishes do not leave an unfavorable environment in favor of a more favorable one as birds seem to do; conditions in the sea are more uniform than on land and fishes do not have to fear winter; neither can fishes look forward to any advantage at the end of their journey.

Any consideration of migration would soon reveal the fact that there are two aspects of the subject: First, the impulses that led to migratory movements in the beginning; and second, the environmental factors that today regularly initiate and direct it. It is obvious that migration has had such a long time for its development that it is futile to argue that any single agency initiated all of the complex migratory movements known today. The origin is almost certain to be associated with the fresh or salt water origin of different groups of fishes at a time when the seas did not have the same salt content that they have today. That is, a period of time so long as to be beyond human comprehension. Migration as a whole expresses the influence of the environment on all fishes for the entire period of their evolution.

Our knowledge of the present actuating causes of migrations is as vague as that of their origin. Undoubtedly the controlling factors are associated with the cyclic nature of the life processes of each species. Temperature, salinity, light, etc., all probably enter. And although feeding migrations are not to be confused with true rhythmical migrations, yet there is usually a period of concentrated feeding preceding every spawning migration. Subsequent to or in connection with this feeding concentration there go on certain physiological changes which are associated with the oncoming of breeding. And while the wane of those same changes after spawning may be sufficient to initiate the return journey, in some fishes such as the eel the return is never completed. All in all migration "appears to be a deep-seated instinct, an instinct so powerful that its promptings must be obeyed, though leading to journeys for which the human mind can find no reasonable explanation."

The Problem Child and the Biology Project

ELEANOR JUNE BEEBE
El Monte Union High School

Schools drawing from the "small farm" area such as the one in which I teach, have to deal with a fundamentally different background and home training than the city schools. As a result of the farmhome and the small town, we in these districts teach students who are not preparing for college, who for the most part would be mentally unable to cope with the demands of pre-college work, and who have shown little interest in obtaining other than a high school education. The result is that we present a practical biology which will be of value in these farm homes.

In the school where I am located, we have a large enrollment in biology, about 350 all told, and because of this the classes have been segregated. This step seems to have met with great favor among both boys and girls. The hour seems to be a rest hour for them from

the other sex, and they like a class in which they can feel free to talk out without embarrassment. These small town children have many problems that are settled for them in the school rather than at home. The girls, whom I teach, are very keen about studying the living things which they have come in contact with. Many of them see so much more than they have ever seen before, that they really feel the biology period has something to offer them. It is surprising, that living on farms as they do, they do not know more about their surroundings.

Sometimes, because of the varied nature of the work, it is possible to help the so-called "problem child" or children with problems. There was one particular instance of such a child in biology last year, whose experience I should like to pass along in the hope that it might aid someone else.

The general background has been sketched, a picture of a girl who lives on a small farm, whose intelligence rating is not high enough for her to study a college preparatory course with any ease, and who is not interested in college. This particular girl is one who does housework and cooks for eight people at home, who does not like school, who never turned in any work, and who was a problem not only for me, but for all of her teachers. Her redeeming feature, I found on talking to her, was her love of flowers. She had a small home garden that she cared for herself. This seemed to be her main, if not only interest. From this talk with her, and this knowledge of her hobby, we worked out a solution for her work in biology, and incidentally for some of her other classes.

The project of growing flowers in the classroom was her idea, and it was her idea to grow them in troughs. She went to the janitor of the school, had him make some troughs to suit her. The trough and the plants in them were hers to care for, fertilize, irrigate, and keep the soil loose in them. She alone was responsible for the growth of the flowers and she took great pride in them. She became so interested in growing things that this proved to be only a part of her project. As each flower bloomed, she told the class about it, its name, its history, the kind of soil required to make the best flower, how much irrigation was needed, what sort of pests attacked it, and what insecticide was used to make it a healthy plant again. Her garden at home was planted with the same flowers, so that she had a comparison for growing flowers in a box and in the open.

So this girl came to school, made her garden and grew her flowers, and in doing this, learned about another great field relating to the study of biology. She found that insects could be both good and bad, some destroyed her plants, others left them alone and destroyed other insects. In order to know one from another, she had to resort to reference books. After she had found which were harmful, she had to learn something of their control. All of this she did of her own accord.

The garden helped her in English in that she wrote about the things that she had been doing with her flowers. In speech class she often repeated the talks she had given about the flowers in her biology class. Because of her new lease on school life, she made better grades.

This "problem child" had been transformed into a desirable student by a garden. When questioned by other teachers as to her deep interest in flowers and awakened interest in school, her reply was, "I've never had anything to do before that I liked, it was fun!"

Editorial Comment

OUR NEXT STEP

During the past six months the association currents have mostly flowed in a one-way stream from the executive board to the membership body. During that period we frequently had the uncomfortable feeling of directing our efforts at an abstract audience. Now that we have had our first national convention, we are convinced that our members are real, that their enthusiasm and interest in the National Association of Biology Teachers is unbounded and that they have endorsed the work already accomplished. We are, furthermore, assured that they are ready to take an active part in furthering the progress of the association. We, therefore, take courage in presenting the following three issues for the careful consideration of our members.

One Our present membership is large enough to support the present activities of the association. But we must grow if we are to become a potent force for the improvement of biology teaching. Our journal must grow in size and quality, our readers must grow in numbers, and above all we must establish and carry out a program which will enrich and extend the teaching of biology in the secondary schools. A greatly increased membership is essential if we are to accomplish these things. Start a membership drive in your locality. Get in touch with your national membership committee chairman, Miss Lucy Orenstein, Evander Childs High School, 800 Gun Hill Road, New York City. She is ready to coordinate the efforts of all and render assistance and advice where needed.

Two The membership body will have its first opportunity to elect officers of the association during the coming spring. A nominating committee of five classroom teachers are already at work seeking candidates. As members of the association you have a right to submit additional names of candidates by petition. Refer to Article II, Section 2 of the constitution for the procedure and send your nominations to the secretary-treasurer no later than January 30th.

Three Up to the present time we have been actively engaged in establishing the mechanism of our organization. Our next and more important task is to outline a program that will encourage the realization of the objectives which we originally incorporated in our constitution. We need to know what our members think the association should be doing for them individually and for biology teaching in general. The pages of the American Biology Teacher are open for the presentation and discussion of your suggestions. Send them to the editor.

In summary we quote from a letter written by Dr. E. V. Cowdry, president of the Union of American Biological Societies, "It is our principal function to integrate the biological specialties and the only way that these specialties can be developed on a sure foundation is through the devotion of biology teachers throughout the land welded into a unit by the National Association which you represent.

"The Union is confident that the National Association of Biology Teachers will grow from strength to strength and will give the citizens of the United States the conception of life in all its aspects and adjustments which is essential if the molding of our body politic is to be conservative, constructive and to the advantage of the whole nation."

Biology Teaching Aids

SODIUM HYPOCHLORITE FOR POISON OAK, POISON IVY, OR POISON SUMAC, PUBLIC PEST NUMBER ONE[2]

To one who has had any experience with public pest number one, Poison Oak, Poison Ivy, or Poison Sumac, the addition of another remedy will be of interest, even though there are already 250 or more remedies listed by McNair (4). Anyone who has tried several of the highly recommended treatments without complete satisfaction with the results will greatly appreciate a perfectly designed treatment consisting of an oxidizing agent in an alkaline medium which gives immediate relief or completely prevents the development of any symptoms if used within a few hours after contact with the poison.

Among the many available methods (1, 3, 4) for the immediate removal of the poison of Poison Oak, Poison Ivy, and Poison Sumac before the poison has had time to penetrate the skin, certain disadvantages are recognized. The potassium permanganate treatment, according to Couch (2), not only destroys the poison, but is an excellent remedy after irritation has begun. It has the disadvantages, however, of (a) not being readily available in many households, (b) of being expensive, (c) of not being alkaline in reaction, and (d) of staining the skin although the stain may be removed by washing with a one per cent solution of oxalic acid or sodium bisulphite or sodium hyposulphite. To this list of destaining agents sodium hypochlorite may now be added. Oral treatments with POISONOK and other partially immunizing preparations are helpful, but also have certain disadvantages.

In view of these disadvantages sodium hypochlorite (NaOCL), which is available in most grocery stores, has been used with gratifying success to remove or oxidize the poison of Poison Oak from or on the skin, clothing and implements or tools, and as a remedy after the poisoning has caused the characteristic symptoms of itchiness, redness and irritation of the skin.

The destruction of the poison by washing in sodium hypochlorite, a well known bleaching agent, is not due to its alkalinity alone. Comparative tests of three per cent sodium hydroxide and commercial sodium hypochlorite in removing the poison of Poison Oak (***Rhus diversiloba*** T. and G.) which had been applied to the backs of the fingers of my left hand showed that the sodium hypochlorite was 100 per cent efficient and superior to sodium hydroxide for this purpose. The full strength or a dilution of 1 : 10 in warm water is effective. For tender skin the diluted solution is preferred.

As a cure, after irritation has begun, repeated applications of the diluted solution (1 : 10) is recommended. A cloth saturated with the solution may be applied directly on the irritated skin and held in place with adhesive tape. It is better to change this application at half-hour intervals rather than to leave the same application on for several hours, although the latter procedure has been successful in some cases checking the irritation almost instantly. More recent experience with the full strength solution applied directly on the irritated skin, repeated a few times, and left exposed to the air has been 100 per cent successful.

Before using sodium hypochlorite as a preventative of, or as a cure for, poisoning from Poison Oak, my own cases of poisoning usually lasted three weeks until apparent recovery, although itchiness continued longer. Now I can handle Poison Oak with my bare hands and the poison can be removed without being followed by any symptoms of poisoning on susceptible parts of the skin. To remove the poison from the hands the full strength of the sodium hypochlorite may be used in the same manner as one would wash with soap and rinse in warm water. It is far superior to soap for destroying the poison on the hands because it penetrates well and only one application is necessary. Furthermore its use as a remedy has been successful in a number of cases, and is 100 per cent efficient in removing the poison from or destroying it on clothing, tools or implements which have been used in cutting or grubbing such poisonous plants. My experience justifies further use of this preparation.

George R. Johnstone,
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Literature Cited

1. Couch, F. F. Poison Ivy and What To Do About It. Scientific Monthly. Vol. 33, 359–362. O. 1931.
2. Johnstone, G. R. The Use of Sodium Hypochlorite in Removing the Poison of Poison Oak from the Skin, Clothing, and Garden Tools. A paper presented before the Western Society of Naturalists. December 30, 1936.
3. Grant, C. V., and A. A. Hansen. Poison Ivy and Poison Sumac and their Eradication. Farmers' Bulletin 1166. U.S.D.A. 1920.
4. McNair, James. Rhus Dermatitis. University of Chicago Press. 1923.

A CULTURE MEDIUM FOR BLACK MOLD OF BREAD

The black mold of bread (*Rhizopus nigricans*) is peculiar in that it spreads over the surface of the nutrient medium. This is accomplished by specialized hyphae called stolons.

Modification of the medium suggested by Dr. C. B. Bridges for the growth and development of the fruit fly, *Drosophila melanogaster*, may be used successfully for the growth of *Rhizopus*, especially if one wishes to obtain a luxuriant growth of submerged hyphae for cytological study.

66 grams of corn meal
14 grams of agar agar
45 cc. Bre'r Rabbit molasses
45 cc. Karo corn syrup
665 cc. water

Upon adding agar agar to the water bring the mixture to a boil. Next, add the corn meal while some one stirs the medium. When the ingredients are well mixed the molasses should be added. Boil slowly for ten minutes.

After the medium has finished cooking pour a small amount (about two inches in depth) into test tubes which have been thoroughly washed and sterilized. Expose for ten minutes and then plug the tubes with absorbent cotton. Tubes containing media which are not used immediately may be stored in a cold place, preferably a frigidaire.

Spores of *Rhizopus*, which are compact masses of protoplasm, germinate upon reaching the medium. As more food is absorbed a germ tube develops from each spore if the temperature is favorable. Branches which are put out by these tubes subdivide to form the mycelium. A microscopic examination of the my-

celium shows numerous nuclei scattered through the cytoplasm. There are no cross walls. This is a typical coenocyte.

Many branching filaments extend from the mycelium into the medium. These are the absorbing branches. If they are removed and observed with a compound microscope an occasional streaming of the granules in the cytoplasm may be seen and also vacuoles of different sizes. The protoplasm moves towards the tips of the various branches.

The erect aerial filaments which bear the sporangia are called sporangiophores. Spores and sporangia receive food from the submerged hyphae for they digest and absorb nutrients of the medium by means of digestive ferments. These digestive ferments pass out of the hyphae and change the nutrients into diffusible and soluble foods. Digestion is extracellular, *i.e.*, it takes place within the medium surrounding the hyphae. The active region of growth is the terminal portion of the hyphae.

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AN OMNARIUM

The problem of having living specimens, either plant or animal, to use just when one wants to teach about them is often quite difficult. Under artificial circumstances they often die, or do not act naturally and so cannot be used as the best examples.

Aquaria for water plants and animals, terraria for those from the land and cages for still others; these require time and attention, and the putting of animals under unreal conditions where they do not react as in more natural environments.

Considering these disadvantages I conceived the idea of constructing within my laboratory an "omnarium"—a place in which everything from earthworms to butterflies, frogs and mosquitoes can be kept.

The dimensions of this "omnarium" may vary according to the need, and the space which can be given it. Mine is four feet long, two feet wide, and two feet high, designed to sit upon a table near the windows. It is built of soft pine; first a box of the length and height given, with solid sides and ends some eight inches high. The corner posts of this box, made of $2'' \times 2''$ material extends sixteen inches above these sides and are enclosed with $\frac{1}{4}''$ hardware cloth. Side and end rails at the top are $2'' \times 2''$, the ends so notched that the side-rails are superimposed about an inch. Into the groove thus formed, a sliding screened lid fits.

In the bottom is a 16 oz. copper pan, fitting the box and having sides at least $2\frac{1}{2}''$ high. This makes a waterproof, rustproof bottom into which water and moist soil can be placed. About half the pan I have filled with rich woods-soil; then a loose dam of stones, and the other portion of the pan is filled with water. Mosses, ferns, lichens, liverworts and other plants are transplanted into the soil; water lilies, Cabomba, algae, Miraphyllum, etc., are placed in the water.

With small turtles, a few snakes, lizards, salamanders, crayfish, insects, worms, etc., the "omnarium" takes on the appearance almost of wild life in its natural state and provides winter-long interest for the children. It requires little care, only the addition of a little water from time to time.

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Pedagogia

Abstracts from the Literature

T. F. MORRISON

CASILLO, N. R., *Recreational Biology.* Pennsylvania School Journal, 87: 101–102; Nov., 1938.

A method of impressing the school-going public, and their elders, of the importance of conserving the wild-life of this country is to stress its recreational value. The Author claims that if the public will not cooperate in preserving wild forms for their own sake, it might be willing to do it if it felt that the depletion of the game birds and animals had a direct effect on their pleasure. This rather realistic view of the Author's is a somewhat unusual approach to the problem and should not be dismissed without due consideration. As he says, it represents a real application of leisure-time Biology.

PRESTON, CARLETON E., *Objectives and Practices.* High School Journal, 21: 266–269; Nov., 1938.

Inertia works against change in the adoption of methods of classroom instruction which are in line with the modern methods of science teaching. Too frequently teachers who have been trained to appreciate these objectives simply render lip-service to them when they go into actual teaching service. Biology is still more of a course in thanatology (*thanatos* = death) than a course stressing the *bios* of the subject.

REAUME, W. J., and DONOHUE, F. J., *Health Education in Detroit.* School and Society, 48: 632–634; Nov. 12, 1938.

The way in which a large city school system teaches health by integrating the work of various Departments is described in this article. Not only do the Biology Departments play an important rôle in the program, but such widely divergent groups as coaching, swimming, and orthopedics all contribute to the work. A table given in the body of the article shows the extensiveness of this city-wide program.

STEVENSON, E. N., *An Investigation into the Relative Effectiveness of Three Different Methods of Teaching Biology in a Normal School.* Journal of Experimental Education, 7: 67–70; Sept., 1938.

The three methods employed in this investigation were: (1) the lecture method; (2) the lecture-discussion method; and (3) the experimental method which was primarily one of problem solving. The results did not indicate that any of the methods showed an appreciable advantage over the others either in the ability of the students to apply principles or in the development of laboratory technique and performance. The experimental method was most effective for immediate and delayed recall as well as gain in knowledge of subject matter. There was evidently little difference in the effectiveness of the methods when they were applied to groups of high or medium ability, although there was some indication that the lecture-discussion method was more satisfactory for groups of low ability. It is interesting to note that the students preferred the lecture method over the other two; their reaction to the experimental method being that they thought it was interesting. The Author concludes that this experiment demonstrates the applicability of the new teaching techniques to students of college level.

An Objective Approach to Biology

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In the approach to his subject, a teacher is in much the same position as a salesman trying to sell his product to a customer. A good salesman knows that most people are concerned more with concrete situations than they are with abstract ideas, so usually he will try to demonstrate the thing he has to sell. Display windows are based upon the elemental fact that most human beings are objective minded. We want to see what we are going to buy, and few of us will buy personal articles through a catalogue or advertisement.

In the same way, a student will not buy from a teacher who attempts to sell his subject through the use of a text book. They, as you and I, must see the real thing if they are to be interested. Objective materials stimulate new ideas for further activities, and when a student is able to point with pride and say, "I made that, that is mine!" the laboratory becomes "our" laboratory, and not the teacher's laboratory. Each addition to the classroom, however small, adds to the silent education of those who do not take part, and slow and backward students feel the joy of objective reality.

Young students, for the most part, are both unwilling and unable to deal with abstract ideas, primarily because they have not had enough concrete experiences to make the ideas understandable. Consequently any method that deals with a purely abstract approach is almost certain to produce passive interest. Passive interest will not endure long among high school students unless some thing is done to make it active.

At first, most students approach a new subject with the eagerness of a child for a new toy. If enthusiasm lags long at the beginning it is very difficult for a teacher to stimulate momentum later by any method. Psychologically, from the standpoint of grasping the immediate interest of the student group, the introduction to the subject matter is probably the most important part of any method. A good beginning may provide the "steam" that may carry a student through the term with interest and enthusiasm.

It is a generally conceded fact that the most direct approach to learning is through the study of the thing itself. This fact has been realized in the teaching of numbers in the primary grades, in which concepts are built up around the concrete things that numbers represent, before any attempt is made to drill on abstract numbers. On the contrary, most medical students will study Comparative Anatomy before they have any very clear generalized concepts of the animals they are studying. To tell such students how different animals chew means little unless they know the animal and the general conditions under which it lives. It is very difficult to get a concept of a cow from a quart of milk.

In the absence of the thing itself, a model may be the next best substitute.

A good model is an exact image of the thing to be studied. Many things are studied in school which cannot be brought into the classroom, as for example, a coal mine or an oil well. For the most part, they must be studied from books, pictures, charts and maps that are available. Our public museums have rendered an excellent service to education by reproducing exact images of living things and natural formations in their natural settings. This particular type of model is known as a diorama. It enables the student to see the relation that exists between the living thing and its environment, a relationship that is not easily obtained through any amount of text book study. Immediately, abstract reading becomes concrete and students who ordinarily obtain little from the printed page begin to understand.

Further, a model or diorama becomes still more instructive, and more objective and understandable if it has been made by the student himself. Such a task requires careful planning and careful observation of details to be able to complete it according to any pre-conceived ideas. It involves, also, the exercise of a certain amount of judgement, together with artistic and mechanical skills to turn out a worthwhile product. The lasting results of learning acquired in this manner, and the training afforded by the work involved cannot be overestimated.

The tremendous possibilities of plastic clay in producing permanent, miniature dioramas for the classroom has scarcely been touched. A few of these possibilities are shown in the illustrations. Plastic clay will not deteriorate with age, nor melt in warm weather. It can readily be torn down and built over, a fact which is most important in producing good work among high school students. In addition it can be painted with oil paints or poster colors to which no water has been added. When the figures are properly supported, and protected by glass in a diorama case, the exhibit becomes a permanent addition to the classroom. Each new addition creates new interest and spurs group activity towards the completion of a museum as the ultimate goal in the Biology Classroom.

It is not hard to "sell" a subject to a student on an activity basis, if interesting objective results of previous activities can be exhibited by the teacher.

The General Plan of Approach

True interest usually results from individual or group contributions to some general plan laid out by the teacher, in which the most gifted and the least gifted student may contribute according to his or her ability.

A Natural Science Museum in the Biology Classroom can be the ultimate objective of such a plan. Many types of interests may be used in building a museum; in fact the variety may become

so great that almost everyone of an entire class may contribute something to the co-operative plan as a whole. The whole thing tends to focus on things that students like to do, although some of the activities have only a remote connection with the subject matter. To place the work on a committee basis sometimes adds to its importance and makes for better work. The following committees have been found helpful in segregating individual interests, and in focusing action towards the museum plan idea, namely:

Art	Plant Studies
Woodwork	Landscaping
Taxidermy	Pond-life Studies
Preserving	Insect Studies
Aquarium Construction	Reptile Studies
Slide Making	Bird Studies
Correspondence	

The Method of Approach

The following introductory method has been found to be successful repeatedly in dealing with students in Biology:

1. An effort is made to get each student to make an early contribution to the laboratory while he is still running on the "steam" of a new situation. Any contribution, however small, makes the laboratory a part of the individual. Abundant suggestions should be offered as "food" for thought.
2. The course is introduced with live material that will captivate interest and promote discussion.
3. Co-operation is emphasized as a means of accomplishing results that could not be acquired by any one individual as, for example:
   - Co-operative planning.
   - Co-operative collecting of working materials and Biological Materials.
   - Co-operative working of special interests as Art and Woodwork to produce a finished product.
4. Emphasis is placed on the various committees that supply a variety of activity suited to individual needs and interests. Arrangements are made to meet each committee after school so that activity is started as soon as possible. Thus active interest displaces passive interest.

Problems Overcome by Student Activity

1. *Live Stock:* Collecting for the classroom museum will supply ample live materials.
2. *Aquariums:* Active interest in stocking aquaria often leads to the construction or repair of additional aquariums for the classroom.
3. *Microscopes:* Photomicrographs made by students interested in photography are very fine substitutes for individual microscopes.
4. *Museum Jars:* Regular museum jars are very expensive. Interested students will bring in hundreds of straight sided pickle jars which are excellent substitutes.
5. *Stuffed Mounts:* Old, stuffed mounts brought in by students can be reconditioned, and over a period of years built up into a large collection.
6. *Wood:* Much good wood can be collected by students in the form of heavy wooden boxes. This wood can be used by the Woodwork Committee to construct various types of display cases.
7. *Glass:* Hundreds of pounds of window glass may be collected during the term. Window glass has a variety of uses in the Biology Classroom.
8. *Marine Life:* Dried specimens brought in by students who have been to the sea shore usually work into a large collection. This fact is especially true of sea shell collections.

These represent a few of the problems that have been solved by student activity. A good museum attracts students from all parts of the school so that interested students as well as interesting biological specimens gravitate towards one's class room.

Developing Individual Pupil Interests in Biology

KARYN BEYETTE SANDERS
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This article contains extracts from a report of an experimental investigation in the teaching of tenth year biology. The problem was to determine the effectiveness of certain experimental materials and procedures in stimulating the interests of high school pupils in the general field of their biological environment. The investigation was concerned with developing individual pupil interests through the use of individual projects and extensive reading, in addition to the generally accepted unit study plan.

The course of study used in the Downey Union High School for the study of biology was not based on a single textbook but upon the use of several basic textbooks, as well as numerous reference materials in the science library, in the biology room. The textbook may be indispensable as a guide in directing the course in biology but even the most comprehensive text is entirely too meager in content to satisfy the interests of some wide-awake pupils. The general movement in education to center instruction around large social situations, to organize work into units of instruction and to use project and problem-solving methods, was not applicable to textbooks only. Modern biology draws on so many fields of knowledge for its materials to fit the interests, needs, and abilities of individual pupils that single textbooks, or, for that matter, multiple textbooks, are inadequate. All the trends in educaton point toward the providing of many sources of material and away from the use of one textbook.

With life activities and interests the center of instruction there were many books available, representing different aspects of the field and presenting various points of view. The information in books was one source of data to be considered in answering a question, solving a problem, or completing a project. It was hoped that the use of several different books used as basic references, would necessitate evaluation of data in finding the best answer, so fostering the scientific attitude, an important aim in education. In order to give access to these varied viewpoints there were available in the biology room several copies each of current editions of the popular textbooks. Besides these were single copies of various other textbooks of biology, botany, zoology, hygiene, and other books from pertinent fields.

Reading was to increase the interests and enjoyment of the pupils in the field of biology and to stimulate reading interests generally. The general interest in biology which is evidenced by pupil enrollment leads inevitably to a variety of forms of extra-class reading. If the reading is done in connection with, or because of, the biology units, it is a distinctive addition thereto, and it is, moreover, an evidence of the interest in that school work. It forms a definite proof that, at least, some of the work of the school is meeting the life interests and problems of its pupils.

The books for the classes varied somewhat in difficulty in order to meet the needs of pupils at different levels of ad-

vancement. Many reference materials intended for junior high school age were included along with references of even college rank for pupils of superior reading ability and intelligence. Two types of reading material with respect to content were provided. The first included information which was essential to the solution of problems and projects, and which should be read carefully for specific purposes. The second included interesting supplementary materials which could be read at the play level during reading periods, in order to broaden and enrich the experiences gained through intensive study.

The papers and magazines of today contain many discussions and stories which deal with scientific subject matter. In order that the pupil might have access to this material, a large table with chairs was placed on one side of the room and copies of the recent issues of scientific periodicals as well as daily newspapers were always on the table. Back numbers of magazines and papers were kept on shelves near by.

Material bearing on different aspects of biology prepared by the various government agencies, federal and state, were kept filed in a cabinet near the reading table. Such material is valuable, up-to-date at the time published and gives much current information.

An annotated reading list of all books in the room library was on the reading table at all times. A subject card file was started by the pupils and supplemented continually. The pupils read as much or as little as they chose; however, they were encouraged to tell the class or report on interesting reading found, and each pupil kept a record of reading done and reports made. Constant efforts were made to encourage reading. Lists of new books, book covers, advertisements, and posters were placed, periodically, on the room bulletin boards.

An important consideration in biology teaching is the need of encouraging the pupil to independent study. The project offers a wide opportunity in stimulating independent thinking, increasing pupil activity and interests in biology. The best project is naturally one that a pupil sets for himself rather than one set by someone else, for enthusiasm to work upon a project must be real, not artificially created. The pupils, therefore, were allowed a free rein in the selection of their projects. At the beginning of the school year the topic of projects was introduced. A mimeographed sheet of suggested projects was given each pupil. These were discussed, added to and pupils interested in the same type project met in group conferences for further discussion and clarification of methods of work. Individual projects were then chosen and the development of working outlines began. These projects were to be continued by each individual just so long as interest was sustained. The classroom became a workroom and groups were called together to report on progress made and for final reports on completed projects.

The purpose of this investigation was to determine the effectiveness of certain experimental materials and procedures in stimulating the interests of high school pupils in the general field of their biological environment. Therefore, means or devices for obtaining evidence of development of individual pupil interests had to be used. At the beginning of the school year these pupils were given a standardized reading test and also a standardized biology test. Questionnaires relating to interests were given several times during the year. Practice tests over small areas of material were given frequently, checked and used

by each student for study purposes. Achievement tests were used both before and after the study of several units. At the close of the year, standardized biology tests and interest surveys were again given to the classes. From the results of all of these tests and the continuous records kept throughout the year, the conclusions for this study was formulated.

In order to give opportunity for much individual work, Tuesdays were set aside for individual projects and Fridays for general reading and reports. The other three days were used for following a general biological course of study, the pupils, however, having a part in selecting units and problems. As these classes in biology were a cross section from the tenth grade, the selection of topics was based on the fact that it was to be a general biological course of study with no thought of preparation for college. The pupil's native curiosity, interests and needs at this level, and the consensus of opinion as expressed by educators in current literature were used as criteria for the selection of topics. An attempt was made to select those phases which were deemed more necessary to the pupil's immediate interests and his future needs.

The units of instruction were chosen and reading lists prepared in order to present a broader and freer method of dealing with subject matter. Units were introduced by using survey questions and a preview of possible problems accompanied by many illustrative materials to make it more interesting and comprehensive. It was hoped that this method would stimulate interest in the unit as a whole and in different problems which might have individual appeal. Selection of definite problems were made by the class yet those who preferred another might use their project period for following it through. Individual differences in abilities and interests were, therefore, taken care of because the pupil was able to concentrate his greatest efforts on those phases of the units which were of most interest to him.

During the periods of assimilation and organization, both of general units and projects, a number of different types of work were used; demonstrations, field work, discussions, visual aids, use of the texts and reference books, individual experiment and continual supervision by the teacher. A variety of methods were used so that, because of this variety, interests would not lag. A notebook was used for records of observations, points made in discussions, brief outlines of source material gathered and pupils own experimental evidence. They were more or less individual, containing that material each pupil felt would aid in organization at the end. The laboratory was made the place where pupils went to clear up any part of the work not understood through class discussion or their own reading. The handling of models, charts, specimens, microscopes, and the projector was for stimulating interests as well as increasing knowledge.

The individual projects and general readings produced some interesting re-

ports and collections. Even useful pieces of equipment for the biology room were outcomes of special interests. Donations of collections, long forgotten in homes, were given to the school during this procedure and the biology room became a source of curiosity and interest for many pupils not in the biology classes. Some of the pupils selected projects suggested by the unit topics being studied at the time. Many others developed projects entirely different from regular work and gained a variety of interests for themselves and interested other pupils in the class watching their work.

Reports, debates, panel discussions, and general discussions were used to summarize the general units. Reports with illustrative material or demonstrations summarized the individual projects. It was necessary continually to encourage and stimulate several of the timid and naturally slow pupils. However, as is shown in case studies, responses was very good even in those with least ability.

Although measurement of the less tangible outcomes, such as interests, ideals, attitudes, appreciations and habits has not yet been accomplished, a review of the case studies bears its own witness as to the awakening and growth of interests in the minds of these pupils. An improvement of 30 points (median) on the subject matter of general biology was expected and there is evidence of a class average improvement of 30.9 plus per cent. These results were obtained using the plan of Tuesdays for individual projects, Fridays for general reading, and leaving three days a week for the acquisition of subject matter from the study of units.

The results of this study seem to justify the use of many supplementary reading materials, and the opportunity for individual projects. In conjunction with the unit topic plan of procedure, these methods of instruction and materials fostered and developed in each individual pupil new and abiding interests in the field of their biological environment.

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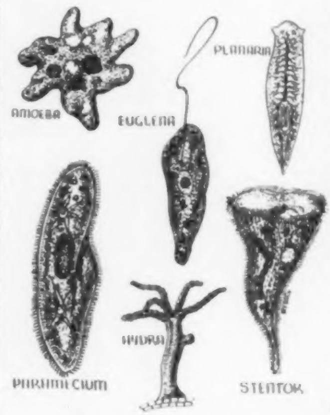

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